U.S. Department of Energy
Office of River Protection
P.O. Box 450
Richland, Washington 99352

04-ESQ-0192

04-WTP-195

SEP 16 2004

Mr. J. P. Henschel, Project Director
Bechtel National, Inc.
2435 Stevens Center
Richland, Washington 99352

Dear Mr. Henschel:

CONTRACT NO. DE-AC27-01RV14136 – APPROVAL OF AUTHORIZATION BASIS AMENDMENT REQUEST (ABAR) 24590-WTP-SE-ENS-04-044, REVISION 0, "REVISE EROSION REQUIREMENTS IN SRD SAFETY CRITERION 4.2-3 AND APPENDIX H TO REFLECT WEAR CALCULATION PARAMETERS"

References:
1. BNI letter from J. P. Henschel to R. J. Schepens, ORP, "Transmittal for Approval: Authorization Basis Amendment Request 24590-WTP-SE-ENS-04-044, Revision 0, Revise Erosion Requirements in SRD Safety Criterion 4.2-3 and Appendix H to Reflect Wear Calculation Parameters," CCN: 085297, dated April 7, 2004.

2. BNI e-mail from S. W. Vail to L. F. Miller, ORP, "RE: Closure of ABAR 04-44 Review," CCN: 094206, dated July 11, 2004.

3. BNI internal memorandum from S. W. Vail to G. M. Duncan, BNI, "Additional Information Regarding Wear Rates Predicted by Karabelas for Vessels and Lines Containing Glass Formers," CCN: 092375, dated July 10, 2004.

4. BNI internal memorandum from S. W. Vail to G. M. Duncan, BNI, "Additional Information Regarding Wear Due to Erosion at Velocities below 12 FPS," CCN: 092376, dated July 11, 2004.

5. BNI letter from J. P. Henschel to R. J. Schepens, ORP, "Transmittal of Decision to Deviate from the Authorization Basis for the Hanford Waste Treatment and Immobilization Plant (24590-HLW-DTD-ENS-04-0007, Revision 0)," CCN: 093509, dated August 3, 2004.

6. BNI e-mail from S. W. Vail to L. F. Miller, ORP, "ABAR 04-044, Erosion Info," CCN: 094216, dated August 11, 2004.

This letter approves ABAR 24590-WTP-SE-ENS-04-0-44, Revision 0, submitted to the U.S. Department of Energy, Office of River Protection (ORP) by Bechtel National, Inc. (BNI) (Reference 1). The attached Safety Evaluation Report (SER) approves changes to Safety Requirements Document (SRD) Safety Criterion 4.2-3 (concerning erosion allowances and evaluation requirements) and SRD Appendix H (the ad hoc standard for erosion/corrosion and assessments). The purpose of these changes is to revise the erosion allowance requirements,

clarify inconsistencies in the current requirements, and revise the conditions which require erosion allowance calculations.

ORP's review of the changes proposed in the subject ABAR and of the changes to the SRD is summarized in the attached SER. Based upon the information in the references and the attached SER, the changes (as modified in the attached SER and subject to the limitations described below) are acceptable, and there is reasonable assurance that the health and safety of the public, the workers, and the environment will not be adversely affected by those changes, and that they comply with applicable laws, regulations, and River Protection Project Waste Treatment and Immobilization Plant (WTP) contractual requirements.

The revised erosion allowances specified in the SRD are specifically only appropriate for those portions of vessels and piping where the process fluid velocity is known to be within the specified velocity limits of applicability. Erosion evaluations for the High Level Waste (HLW) feed and feed preparation vessels must consider the prevention or mitigation of erosion of the vessel and vessel internals, related to air sparger induced flow, prior to final design and procurement of the portions of these stainless steel vessels or vessel internals subjected to velocities of waste containing glass formers greater than 10 feet-per-second (fps). This limitation specifically applies to the decision to deviate requested in Reference 5. These evaluations should incorporate lessons learned from the premature failure of HLW feed preparation vessels, due to accelerated erosion of the vessel walls due to sparger perforation due to accelerated sparger tube erosion, that were reported in operations at the Savannah River TNX and DWPF facilities in 1989 and 2002, respectively.

The erosion allowance approved by this correspondence for flow (with fluid velocity less than 12 fps) in piping and vessels with no glass formers, is limited to solids concentrations up to 29 wt%, assuming continuous operation, based on the BNI responses in Reference 2. Any increase in the velocities or slurry concentrations in the vessels and piping beyond these values shall be justified by a calculation that demonstrates adequate erosion allowance for 40-year plant life with the higher velocities or concentrations for the specified materials.

Finally, the wear allowance calculation referenced by this ABAR, 24590-M5C-50-00004, Revision B, *Wear Allowances for WTP Waste Slurry Systems*, does not account for erosion consistent with the information supplied to ORP for this review in the references. This calculation should be revised to reflect the non-zero erosion at velocities less than 12 fps in piping and vessels with no glass formers, as discussed in the attached SER.

The proposed changes associated with the ABAR are effective immediately and shall be fully implemented within 30 days; i.e., the provisions may be used immediately. Within 30 days, controlled copies of the SRD must be modified to reflect the proposed changes associated with this ABAR.

If you have any questions, please contact me, or your staff may call Lewis F. Miller, Jr., WTP Safety Authorization Basis Team Leader, (509) 376-6817.

Sincerely,

Roy J. Schepens
Manager

WTP:LFM

Attachment

cc w/attach:
M. T. Sautman, DNFSB
J. M. Eller, PAC

**Safety Evaluation Report (SER)
of Proposed Authorization Basis Amendment Request (ABAR)
24590-WTP-SE-ENS-04-044, Revision 0
of Safety Requirements Document (SRD) Changes
for the River Protection Project Waste Treatment and Immobilization Plant (WTP)**

1.0 INTRODUCTION

This SER documents the U.S. Department of Energy, Office of River Protection (ORP) evaluation of changes proposed by Bechtel National, Inc. (the Contractor) involving revisions to standards and requirements for erosion allowances and erosion evaluations. The purpose of this modification is to revise the erosion allowance requirements, clarify inconsistencies in the current requirements, and revise the conditions which require erosion allowance calculations. This ABAR proposes to do this through revisions to SRD Safety Criterion 4.2-3 and Appendix H.

2.0 BACKGROUND

The WTP authorization basis is the composite of information provided by a Contractor in response to radiological, nuclear, and process safety requirements that is the basis on which ORP grants permission to perform regulated activities. The authorization basis includes that information requested by the Contractor for inclusion in the authorization basis and subsequently accepted by ORP. The Preliminary Safety Analysis Report (PSAR) describes the analyzed safety basis for the facility, demonstrates that the facility will perform and be operated such that the radiological, nuclear, and process safety requirements are met, and demonstrates adequate protection of the public, workers, and the environment.

The SRD is part of the authorization basis for WTP construction. These changes are effective immediately.

3.0 EVALUATION – SPECIFIC CHANGES TO SRD (ACCEPTABLE, AS MODIFIED)

3.1 Proposed Revised Text – Safety Criterion 4.2-3, Item 2 The second item in this criterion has been proposed to be changed as follows:

Current SRD: "Velocities above about 10 fps for slurries shall be evaluated for erosion."

Proposed revised SRD: "The velocity in the vessels and piping containing glass formers shall be less than 10 fps, and the velocity in the vessels and piping containing greater than 2 weight percent solids without glass formers shall be less than 12 fps. Any increased velocities shall be justified by calculation."

Acceptable, modified SRD: "The velocity in the vessels and piping containing glass formers shall be less than 10 fps, and the velocity in the vessels and piping containing greater than 2 weight percent solids without glass formers shall be less than 12 fps. An erosion allowance of 17

mils for the 40 year plant life shall be assumed for solids concentrations less than 2 weight percent, and an erosion allowance of 75 mils for solids concentrations between 2 and 29 weight percent maximum solids concentration shall be assumed for velocities less than 12 fps. Any increase in the velocities or slurry concentrations in the vessels and piping beyond these values shall be justified by calculation that demonstrates adequate erosion allowance for 40 year plant life assuming the higher velocities or concentrations for the specified materials."

Evaluation (acceptable, as modified): This proposal changed (and clarified) the velocity criteria for requiring erosion evaluations for slurry flow (with greater than 2% solids) that did not contain glass formers to 12 feet-per-second (fps) (from 10 fps), and left unchanged the velocity criteria for erosion evaluations for slurries containing glass formers at 10 fps. Implicitly, the new standard also permits slurry flows with less than 2 weight percent solids with no glass formers to have a zero erosion allowance, and requires no evaluation of erosion for slurry flow without glass formers for velocities less than 12 fps.

The Contractor, in its first response to questions concerning the ABAR, stated that below a solids concentration of 2 weight percent, "particle erosion would not be significant, because the abrasivity of the slurry drops significantly" as the weight percentage of solids drops; e.g., from a Miller number of 94 at 12.5 weight percent sand slurry to a Miller number of 0 at 0 weight percent sand slurry. Sand, in a 3 weight percent solids slurry, has a Miller number of 50, and the Miller number of the WTP waste slurry at 2 weight percent was estimated to be only 8. Finally, the Contractor in CCN: 094206, S. Vail to L. Miller email dated July 11, 2004, by extrapolating data from the Fan Aiming, Wang, and Gupta papers referenced in the calculation 24590-M5C-50-00004, Revision B, *Wear Allowances for WTP Waste Slurry Systems*, the Contractor bounded the erosion wear at 12 fps for 2 weight percent solids slurry without glass formers in continuous use to be no more than 17 mils in the forty year plant life. Therefore, based on this information, the reviewer concluded that it was acceptable to not require erosion evaluations for slurry flow without glass formers for solids concentrations less than 2 weight percent, provided a 17 mil erosion allowance is required in this regime.

The Contractor further stated, in the ABAR, that the basis for not requiring evaluation of erosion for slurry flow without glass formers with velocities less than 12 fps was provided in the calculation 24590-M5C-50-00004, Revision B, *Wear Allowances for WTP Waste Slurry Systems*. The reviewers found that the calculation only described why erosion increased exponentially with velocities greater than 12 fps, but did not provide a basis for concluding that no erosion could be expected at lower velocities. Indeed, in CCN: 094206 referenced above, the Contractor stated that the erosion for solids concentrations between 2 and 29 weight percent at velocities up to 12 fps would be bounded by the existing wear allowance of 93.75 mils as demonstrated by a curve fit to data from papers by Fan Aiming, Wang, and Gupta referenced in the calculation that indicates no more than 75 mils wear in the forty year plant life, provided solids concentration was not greater than 29 weight percent and the velocity was not greater than 12 fps. After review of this information, the reviewer concluded that further evaluation of erosion for slurry flow without glass formers with velocities less than 12 fps was not required, provided a 75 mil erosion allowance and a 29 weight percent solids concentration was assumed in the design in this regime.

The proposed change was therefore accepted, as modified above, based on the additional information provided by the Contractor in the cited references above.

The reviewer noted that the wear allowances in 24590-M5C-50-00004, Revision B, *Wear Allowances for WTP Waste Slurry Systems* did not account for erosion in vessels and piping without glass formers at velocities less than 12 fps consistent with the references. This calculation should be revised to reflect the non-zero erosion expected at those velocities.

3.2 Proposed Revised Text – Safety Criterion 4.2-3, Item 8

Current SRD: "Where the solids content is greater than 2 % by weight, a minimum corrosion/erosion allowance shall be provided or hard overlay shall be provided in areas of high velocity."

Proposed revised SRD: "The required wear allowance due to corrosion shall be justified in a corrosion evaluation. The wear allowance due to erosion shall be justified in a calculation."

Acceptable revised SRD: "The required wear allowance due to corrosion shall be justified in a corrosion evaluation. The wear allowance due to erosion shall be justified in a calculation." (No change to proposed revised SRD)

Evaluation (acceptable): The proposed criteria is more complete, since it requires a corrosion and an erosion wear allowance to be justified in a calculation, without exception. Moreover, the option to rely on "hard overlay," which is ambiguous, in lieu of a corrosion or erosion evaluation, is eliminated, removing some ambiguity in the existing criteria. For these reasons, the proposed revised criterion is acceptable.

3.3 Proposed Revised Text - Appendix H, Section 3.10

Current SRD: "Velocities above about 10 fps for slurries shall be specifically evaluated. The typical velocity in the lines is less than about 8 fps. Combined with the softness of the Hanford waste, little erosion is expected. In areas where glass formers are present, a hard overlay (Stellite) shall be used to protect vessels and piping shall have a larger erosion allowance."

Proposed revised SRD: "The wear due to erosion will be justified in a calculation."

Acceptable revised SRD: "The wear due to erosion will be justified in a calculation." (No change to proposed revised SRD)

Evaluation (acceptable): The proposed criteria is more complete, since it requires an erosion wear allowance to be justified in a calculation, without exception. Informational text which does not specify requirements has been deleted. A requirement for Stellite overlay in areas where glass formers are present has been deleted. The amount of Stellite overlay was not previously specified, so the degree of protection that would have been provided had not been previously calculated or specified. This deletion was justified by the compensating requirement to calculate erosion wear, and the fact that the previous requirement for Stellite was vague. The proposed

requirement will permit the use of any material provided adequate erosion allowance is calculated.

3.4 Proposed Revised Text – Appendix H, Section 4.0

Current SRD: "Where the solids content is greater than 4 % by weight, a minimum corrosion/erosion allowance of 0.125 inch shall be provided or hardfacing shall be provided in areas of high velocity."

Proposed revised SRD:

- "Vessels and piping containing glass formers shall have a velocity less than 10 fps. Erosion in flow stream containing glass formers is expected to be less than 0.125 inch in stainless steel over 40 years provided the velocity is less than 10 fps. The required wear allowance for erosion due to increased velocities or the use of different materials shall be justified by calculation.

- Vessels and piping containing greater than or equal to 2 weight percent solids without glass formers shall have a velocity less than 12 fps. Due to the small particle size and relative hardness of the Hanford waste, little erosion is expected in the process flow streams without glass formers at velocities below 12 fps. The required wear allowance from erosion due to velocities greater than 12 fps shall be justified by calculation."

Acceptable revised SRD:

- "Vessels and piping containing glass formers shall have a velocity less than 10 fps. Erosion in flow stream containing glass formers is expected to be less than 0.125 inch in stainless steel over 40 years provided the velocity is less than 10 fps. The required wear allowance for erosion in these cases shall be 0.125 inch. The required wear allowance for erosion due to velocities greater than 10 fps or the use of different materials shall be justified by calculation.

- Vessels and piping containing greater than or equal to 2 weight percent solids without glass formers shall have a velocity less than 12 fps. The required wear allowance for erosion in these cases shall be .075 inch provided solids concentration is less than or equal to 29 weight percent. The required wear allowance for erosion due to velocities greater than 12 fps or concentrations greater than 29 weight percent shall be justified by calculation."

Evaluation (acceptable, as modified): This change clarified, and modified the previous requirements, as follows:

- A minimum *erosion* allowance of 0.125 inch was specified, rather than a corrosion erosion allowance; this change is acceptable, since the intent of the requirement was to describe acceptable velocity criteria for limits on erosion, not to include the additional effects of corrosion.

- The option to provide an unspecified amount of hard overlay in lieu of a specific corrosion/erosion allowance was removed; this change is acceptable since the deletion of this

option does not reduce safety margins, and it clarifies the remaining requirement for a specific erosion allowance.

- The specified concentration of solids at which a minimum corrosion/erosion allowance was .125 inch was decreased from 4 percent to 2 percent (and was for an erosion allowance only) for flow in vessels and piping with glass formers. These changes are acceptable because they increase safety margins, and are consistent with the supporting information in CCN: 094206, CCN: 092375, and calculation 24590-M5C-50-00004, Revision B, *Wear Allowances for WTP Waste Slurry Systems*.

- ORP requested, and the Contractor agreed to, modification of its proposal to change the term "increased velocities" to "velocities greater than 10 fps" and "velocities greater than 12 fps" for slurries containing glass formers, or not containing glass formers, as applicable. This change added specificity and clarity to the proposed change.

- Finally, the requested modification added the sentence, "Due to the small particle size and relative hardness of the Hanford waste, little erosion is expected in the process flow streams without glass formers at velocities below 12 fps." This sentence applied to vessels and piping containing greater than or equal to 2 weight percent solids without glass formers. This proposed modification was not approved, since as discussed in CCN: 092376, the Contractor calculated that some erosion could be anticipated, as discussed above. To accommodate the potential for erosion discussed in CCN: 092376 at velocities less than 12 fps in flow without glass formers, the limits in the modified criteria above were imposed, based on the Contractor's submitted information.

  The reviewers concluded that the changes were acceptable, as modified, for the reasons cited above.

4.0 CONCLUSIONS

On the basis of the considerations described above, ORP has concluded there is reasonable assurance that the health and safety of the public, the workers and the environment will not be adversely affected by the changes proposed by ABAR 24590-WTP-SE-ENS-04-044, Revision 0, and subsequent modifications defined in this SER and agreed to by the Contractor. The proposed changes, with the identified modifications, do not constitute a significant reduction in commitment or effectiveness relative to the design, construction, and operation of Important to Safety structures, systems, and components. Accordingly, the proposed changes are acceptable and ORP approves the changes to the SRD, as proposed in 24590-WTP-SE-ENS-04-044, Revision 0, and modified in this SER.